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AN INFLUENCE OF PULSED ELECTROMAGNETIC EXPOSURE AND CONTAINERS ON SEED STORABILITY OF BLACKGRAM

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ABSTRACT

Superior storage is the basic requirement in seed production programme as maintenance of high seed viability and vigour from harvest to planting is of utmost importance in seed storage. Therefore, inexpensive, effortless and realistic technology to extend the shelf life of seeds under ambient condition is immensely needed. Moreover, a cost effective treatment is to be evolved for blackgram seed storage where Callosobruchuschenens is caring qualitative and quantitative loss. Hence, an experiment was conducted at the Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore during 2017, to study the effect of pulsed electromagnetic exposure with a strength of 500 "T, 750 "T and 1500 "T on the seeds for 5 hr per day for 15 days at different combinations of exposure under ambient conditions. The seed without electromagnetic exposure was considered as control. The treated and untreated seeds were stored in cloth bag and super grain bag. The results revealed that, pulsed electromagnetic exposure on seeds were significantly superior in controlling the storage insect and maintaining higher seed quality up to nine months of storage when compared to control. Among the treatments, the 500 "T + 750 "T strength and seeds packed in super grain bag found better by recording significantly higher germination percentage (92%), dehydrogenase activity (1.729) lower moisture content (8.7%), electrical conductivity (52.8 μS cm^{-1} g^{-1}) when compared to control at the end of nine month of storage and the treatment had been considered as effective seed storage management approach in blackgram seeds.

KEYWORDS*: *Blackgram, Pulsed Electromagnetic Exposure, Containers & Physiological and Biochemical parameters

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Original Article

INTRODUCTION

Blackgram (*Vigna mungo* (L.) Hepper) belongs to Leguminaceae family occupies a unique place among pulses for its use as seed and vegetable and it is grown both as pure and mixed crop. Since it is native to India, suppliments the income of many small scale farmers and contributes to the maintance of soil fertility by fixing nitrogen in the soil. Blackgram is considered as one of the rich protein food, contains about 26 % protein, 1.2% fat and 56.6% carbohydrates on dry weight basis and it is rich source of calcium and iron considering the importance and to augment the productivity of blackgram crop quality seeds play a major role. The quality of seeds in storage is

influenced by several factors like variety of seed, initial seed quality, storage condition, moisture content, insect pest, bacteria and fungi. Blackgram itself is microbiotic in nature and the poor storability is due to infection of *Callasobruchus chenensis* (L.) and *C. maculates* (F.) of *Bruchidae* family, which causes qualitative and quantitave losses. Therefore, maintenance of seed viability and vigour during storage is a matter of prime concern. Maintenance of seed quality during storage period is important not only for successful crop production but also for maintaining the quality and integrity of the seed that are inconstant threat of genetic erosion (Barua *et al.,* 2009). To maintain the quality of seeds during storage the standardization of suitable seed treatments and packaging material is most important because seed treatment is the basic measure to assure adequently healthy crops at emergence and during further growth of plants (Wani *et al.*, 2014). Duruigbo, (2018) reported that pulsed electromagnetic exposure can also reduce the infestation of *Callasobruchus chenensis* there by the storability of blackgram seeds can also be improved. Therefore, an experiment was made to study the influence of pulsed electromagnetic seed treatment on storability of blackgram seeds under ambient conditions.

MATERIALS AND METHODS

The experiment was carried under ambient conditions (mean temperature 28 ± 2^{o}C and RH 70 ± 2%) at the Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore during 2017-18. The experiment was laid out in completely randomized block design with four replications. The blackgram seeds var.VBN (Bg) 6 were collected from National Pulses Research Centre, Pudukkottai, Tamil Nadu as fresh, dried to the recommended safe moisture content of 8 per cent . The seeds were packed in cloth bag and super grain bag

Super grain bag makes the principle of hermetic storage available to farmers at low cost. The IRRI Super Bag is a farmer-friendly storage bag that allows cereal grains and other crops (e.g., maize or coffee) to be safely stored from 6 to 12 months and control insect grain pests (without using chemicals). It is resealable, airtight, moisture-proof safe and transportable storage container for dry commodities. Seed samples were exposed under pulsed electromagnetic using (Biotron device) for the following magnetic electro wavelength and duration.

Table 1

Treatments	Magnetic Field Strength	Duration
T_0	Control	
T_1	500 ^{n}T	5 hr per day for 15 days.
T_2	750 ^{n}T	5 hr per day for 15 days
T_3	1500 ^{n}T.	5 hr per day for 15 days
T_4	500 ^{n}T + 750 ^{n}T	Each 5 hr per day for 15 days
T_5	750 ^{n}T +1500 ^{n}T.	Each 5 hr per day for 15 days
T_6	500 ^{n}T +1500 ^{n}T.	Each 5 hr per day for 15 days

Pulsed Electromagnetic Exposure - BIOTRON DEVICE

Figure 1

The seeds without magnetic wavelength exposure were treated as control. After the treatment seeds in both cloth bag and super grain bag were stored under ambient conditions (temperature 28 ± 2^{o}C and RH 70 ± 2%). Data were collected on seed samples drawn from each treatment on moisture content (%), seed germination (%), electrical conductivity (µS cm^{-1} g^{-1}) and dehydrogenase activity (OD), at monthly intervals upto nine months.

Moisture Content

Five gram of ground seed material was placed in a moisture weighing bottle and kept in a hot air oven maintained at 130 ± 2^0 C for 1 h for drying and cooled in a desiccator containing silica gel for 30 min. The weight of seeds along with moisture bottle before and after drying was recorded in the gram. The moisture content was calculated using following formula and expressed as percentage (ISTA, 2011).

$$\text{Moisture content (\%)} = \frac{M_2 - M_3}{M_2 - M_1} \times 100$$

Where,

M_1 – Weight of moisture weighing bottle alone

M_2 – Weight of moisture weighing bottle + seed sample before drying

M_3 – Weight of moisture weighing bottle + seed sample after drying

Germination

Germination test was conducted by following the Seed Testing Rules outlined in ISTA (2011) with roll towel medium using 4 x 100 seeds in a germination room maintained at 25 ± 2°C temperature and 95 ± 3 % RH. After the seven days, the seedlings were evaluated. Based on normal seedlings, the germination was calculated adopting the following formula and the mean expressed as percentage.

$$\text{Germination (\%)} = \frac{\text{Number of normal seedlings}}{\text{Total number of seeds sown}} \times 100$$

Electrical Conductivity of Seed Leachate

Four replicates of fifty seeds were drawn from each treatment and container prewashed well with distilled water and then soaked in 75 ml of distilled water for duration 6 h (Sathesh, 2013) at room temperature. After soaking, the seed steep water was decanted to obtain the seed leachate. Using Digital Conductivity meter (EUTECH Pc 510) with a cell constant of one, the electrical conductivity of the seed leachate was measured and the mean expressed as µS cm^{-1} (Presley, 1958).

Dehydrogenase Activity

Randomly selected twenty five seeds were preconditioned by soaking in water for 6 h. Then the seeds were bisected longitudinally into two halves and were steeped in 0.1 % 2, 3, 5 triphenyl tetrazolium chloride solution and kept in dark for 2 h at 40°C for staining. After staining, the excess solution was drained and the seeds were washed thoroughly with distilled water and transferred to a test tube containing 5 ml of 2-methoxy cellosolve. The test tubes were closed air tightly

and allowed to remain in an incubator in darkness, overnight for extracting the red coloured formant. The coloured solution was decanted and the colour intensity was measured using Cary UV spectrophotometer at 470nm and methyl cellosolve as the blank (Kittock and Law, 1968). The OD values obtained were from each treatment reported as total dehydrogenase activity

Statistical Analysis

The experimental data were analyzed using the Statistical, according to the completely randomized design. Values were compared by three-way analysis of variance (ANOVA) and mean differences were determined using the least significant difference, at the 5% level of significance.

RESULTS AND DISCUSSIONS

Moisture content of stored seeds was significantly influenced by seed treatment, container, storage period and their interaction (Table 2). Irrespective of period of storage and container, after nine months of storage seed treatment with 500 ^{n}T + 750 ^{n}T for 5 h for 15 days significantly lowered the increase of seed moisture content of 8.7 per cent compared to control seeds (9.6 per cent). Between the containers, seed stored in super grain bag registered the lowest moisture of 8.7% than cloth bag (9.5%).

The interaction between treatment and period of storage revealed that the seed treatment with 500 ^{n}T + 750 ^{n}T for 5h for 15 days registered the lower moisture of 9.1 per cent at followed by 500 ^{n}T + 1500 ^{n}T (9.4 %) at the end of the nine months of storage while the untreated control seeds recorded the highest moisture of 10.3 per cent by absorbing atmospheric moisture (Table.2). The period and container of storage expressed that seed stored in super grain bag sustained slight increase in moisture content from 8.1% (P_1) to 8.7% (P_9). Cloth bag being a pervious nature moisture exchange took place frequently until it reaches the equilibrium status with environment where as super grain bag is impervious as accordance with the results by Jeya *et al*. (2014). Similar findings were reported by Lei Zhang *et* al. (2005) in spinach. Cloth bag being a pervious container, moisture exchange took place frequently until it reached the equilibrium status with environment, thereby this recorded higher moisture at the end of storage period. Super-grain bag which may be attributed to the impervious nature to moisture vapours and thus it has caused less fluctuation in seed moisture content and it eliminates dampness, deterioration, microorganisms and enhance the seed longevity. These findings were in conformity with the results of Shanthappa Tirakannanavar and Ramaiah (2006) in redgram and Basavegowda *et al.* (2013) in chickpea who reported that less fluctuation in seed moisture in the impervious packaging materials as compared to cloth bag.

Germination percentage of stored seeds in irrespective of period of storage and container, with the treatment of 500 ^{n}T + 750 ^{n}T for 5h for 15 days recorded significantly higher germination of 92 per cent compared to untreated control seeds (80 per cent). Between the containers, seed stored in super grain bag registered the highest germination of 92% than cloth bag (85%). The interaction between treatment and period of storage revealed that the seed treatment with 500 ^{n}T + 750 ^{n}T for 5h for 15 days registered the higher germination of 89 per cent followed by 500 ^{n}T + 1500 ^{n}T (86 per cent) at the end of the nine months of storage while the untreated control seeds recorded the lowest germination of 77 per cent (Table. 3). The period and container of storage expressed that seed stored in super grain bag maintained germination from 100% (P_1) to 92% (P_9), during storage. Generally free radicals are atoms, molecules or ions with unpaired electrons, which are highly reactive to chemical reactions with other molecules, in the biology system. Antioxidant protects and prevents oxidative deterioration of lipids and maintains structural and functional integrity of cells. Better membrane integrity in treated seeds by the antioxidant enzyme during storage period, could be one of the reason for maintain of germination in the treated and seeds

packed in super grain bag.

The electrical conductivity was lowest in seeds treated with T_4 - 500 ^{n}T + 750 ^{n}T seeds (52.8µS cm-1 g-1) in super grain bag at the end of nine months of storage compared to cloth bag (57.6 cm-1 g-1) [Figure-2] . The interaction between treatment and period of storage revealed that the seed treatment with 500 ^{n}T + 750 ^{n}T registered the lower electrical conductivity of (55.3 µS cm-1 g-1) at followed by 500 ^{n}T + 1500 ^{n}T (55.9 µS cm-1 g-1) at the end of the nine month of storage while the untreated control seeds recorded the highest electrical conductivity of (59.4 µS cm-1 g-1) [Table-3]. The variation in electrical conductivity of seed leachate indicates increased membrane permeability and decreased compactness of seed coat and cellular membrane deterioration; stable cell membrane also rendered resistance to peroxidase and free radical reactions. Similar, findings were reported by Vasundhara and Bommegouda (1999) in groundnut.

Decrease in enzymatic activity in stored seeds with increase in storage period resulted reduction in germination and vigour as reported by Khan *et al.*, 2013. Chen and Zhou (1990) observed similar increase in electrical conductivity, soluble sugar and amino acids with ageing of rice hybrids. When the seed storage period prolonges leachate from the seeds also increased during ageing process and thus seed quality decreased. This might be due to faster deterioration of cell membrane and also oxidation of polyunsaturated fatty acids in the membrane lipid compounds involving free radical chain reaction (Srivastava, 1975). Loss of membrane integrity during storage would be the main reason for increased electrical conductivity and also evidenced by structural change and changes in membrane composition (Delouche and Baskin, 1973).

The dehydrogenase activity was highest in seeds treated with 500 ^{n}T + 750 ^{n}T (1.729) in super grain bag at the end of nine months of storage compared to cloth bag (1.658) [Figure-3]. The interaction between treatment and period of storage revealed that the seed treatment with 500 ^{n}T + 750 ^{n}T registered the higher dehydrogenase activity of (1.694) at followed by 500 ^{n}T + 1500 ^{n}T (1.675) at the end of the nine month of storage while the untreated control seeds recorded the lowest dehydrogenase activity of (1.497) [Table-4].

The marked decrease in the seed quality parameters under advancing period of storage may be attributed to seed coat characters, age induced physicochemical seed deterioration, lipid peroxidation leading to production of toxic metabolites that may denature of proteins and enzymes of cell and cell organelles. Similar result was reported by Pramila (2003) in black gram.

According to Labes, (1966) it is evident that magnetic fields influence the structure of the cell membrane and increase of permeability and ion transport in the ion channels, which may affects the metabolic pathway Changes in the intracellular level of Ca 2þ and ionic current density across the cellular membrane alters the osmotic pressure and changes the capacity of cellular tissue to absorb water (Garcıa-Reina and Arza-Pascual, 2001). The magnetic exposure dose response studies on seed characters showed that 150 and 200 mT fields for 60 and 90 min significantly enhanced seedling parameters in various crops.

CONCLUSIONS

It is evident from the present investigation that the seed stored in moisture pervious container of cloth bag showed poor quality parameter of decreased germination where is evident from lowest dehydrogenase activity and higher EC value due to increase seed quantitative losses and greater fluctuations in moisture content due to permeable nature of cloth bag to moisture vapours. The strength pulsed electromagnetic exposure with 500 ^{n}T + 750 ^{n}T, 500 ^{n}T + 1500 ^{n}T and stored in

super grain bag were considered as effective seed storage management approach in blackgram. Among the seed treatments, exposure with electromagnetic wavelength of with 500 ^{n}T + 750 ^{n}T recorded higher seed quality parameters throughout the storage period and packed in super grain bag maintained seed quality above the minimum seed certification standards up to nine months, proved that one of the safest, economical, eco-friendly and non-harmful approach of seed management to maintain the germination and other quality parameters of blackgram during storage.

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APPENDIX

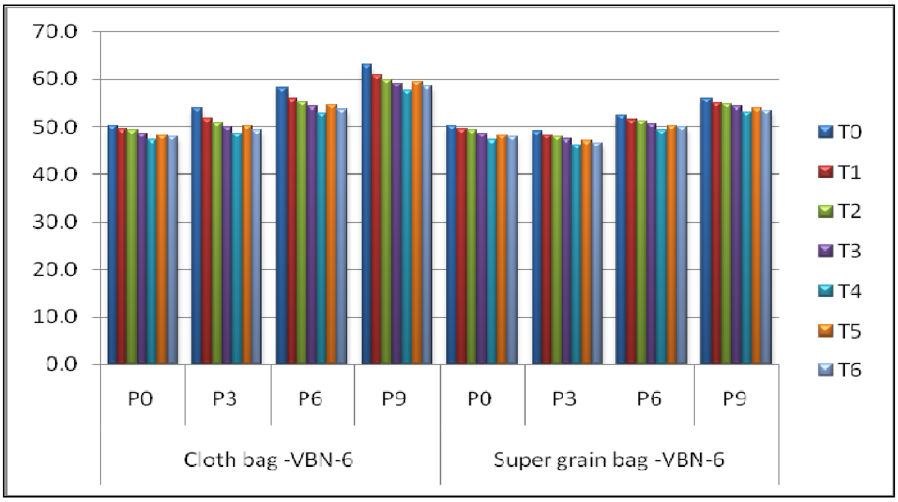
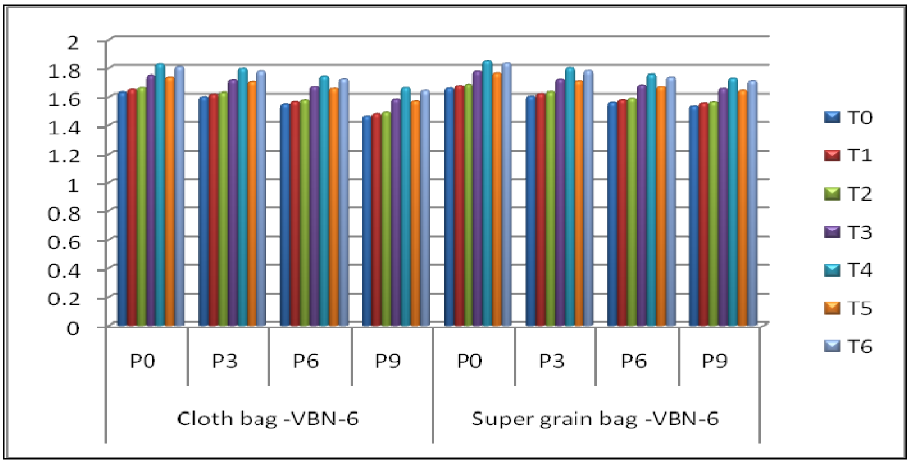


Figure 2: Influence of Pulsed Electromagnetic Treatments, Storage Containers and Period of Storage on Electrical Conductivity (µS cm^{-1} g^{-1}) of Blackgram VBN (Bg) 6



To-Control, T1-500 ^{n}T, T_2- 750 ^{n}T, T_3- 1500 ^{n}T. T_4- 500 ^{n}T + 750 ^{n}T,
T_5-750 ^{n}T + 1500 ^{n}T, T_6- 500 ^{n}T +1500 ^{n}T

Figure 3: Influence of Pulsed Electromagnetic Treatments, Storage Containers and Period of Storage on Dehydrogenase Activity (OD value) of Blackgram VBN (Bg) 6

Table 2: Influence of Pulsed Electromagnetic Treatments, Storage Containers and Period of Storage on Moisture Content (%) of Blackgram VBN (Bg) 6

Treatments (T)	**Period of Storage (P) in Months**									
	Cloth Bag					**Super Grain Bag**				
	P_0	**P_3**	**P_6**	**P_9**	**MEAN**	**P_0**	**P_3**	**P_6**	**P_9**	**MEAN**
T_0	8.1	8.6	9.5	10.9	**9.3**	8.1	8.4	9.0	9.6	**8.8**
T_1	8.1	8.4	9.3	9.4	**8.9**	8.1	8.3	8.7	9.2	**8.6**
T_2	8.1	8.4	9.3	9.4	**8.9**	8.1	8.3	8.8	9.1	**8.6**
T_3	8.1	8.3	9.0	10.1	**8.9**	8.1	8.2	8.6	8.8	**8.4**
T_4	8.1	8.2	8.7	9.5	**8.6**	8.1	8.1	8.4	8.7	**8.3**
T_5	8.1	8.4	9.1	10.2	**9.0**	8.1	8.2	8.7	9.1	**8.5**
T_6	8.1	8.3	8.9	9.8	**8.8**	8.1	8.2	8.6	8.9	**8.5**
Mean	**8.1**	**8.4**	**9.1**	**9.9**		**8.1**	**8.2**	**8.7**	**9.1**	
TXP	**P_0**	**P_3**	**P_6**	**P_9**	**MEAN**					
T_0	8.1	8.5	9.3	10.3	**9.0**					
T_1	8.1	8.4	9.0	9.3	**8.7**					
T_2	8.1	8.4	9.1	9.2	**8.7**					
T_3	8.1	8.3	8.8	9.5	**8.7**					
T_4	8.1	8.2	8.6	9.1	**8.5**					
T_5	8.1	8.3	8.9	9.7	**8.7**					
T_6	8.1	8.3	8.8	9.4	**8.6**					
Mean	8.1	8.3	8.9	9.5						
	T	**P**	**C**	**TxP**	**PxC**	**TxC**	**TxPxC**			
SEd	0.038	0.029	0.020	0.077	0.041	0.055	0.110			
CD(P=0.05)	0.076	0.058	0.041	0.153	0.082	0.108	0.217			

To-Control, T1-500 ^{n}T, T_2- 750 ^{n}T, T_3- 1500 ^{n}T. T_4- 500 ^{n}T + 750 ^{n}T,
T_5-750 ^{n}T + 1500 ^{n}T, T_6- 500 ^{n}T +1500 ^{n}T**.**

Table 3: Influence of Pulsed Electromagnetic Treatments, Storage Containers and Period of Storage on Germination (%) of Blackgram VBN (Bg) 6

	Period of Storage (P) in Months									
Treatments (T)	**Cloth Bag**					**Super Grain Bag**				
	P_0	**P_3**	**P_6**	**P_9**	**MEAN**	**P_0**	**P_3**	**P_6**	**P_9**	**MEAN**
T_0	97 (80.03)	92 (73.57)	79 (62.73)	74 (59.34)	**86** (68.03)	97 (80.03)	93 (74.66)	83 (65.65)	80 (64.43)	**88** (69.73)
T_1	97 (80.03)	94 (75.84)	82 (64.90)	78 (62.03)	**88** (69.73)	97 (80.03)	95 (77.08)	86 (68.03)	83 (65.65)	**90** (71.57)
T_2	97 (80.03)	94 (75.84)	83 (65.65)	79 (62.73)	**88** (69.73)	97 (80.03)	95 (77.08)	87 (68.67)	84 (66.42)	**91** (72.54)
T_3	97 (80.03)	95 (77.08)	88 (69.73)	80 (63.43)	**90** (71.57)	97 (80.03)	96 (78.46)	92 (73.57)	89 (70.63)	**94** (75.82)
T_4	100 (90.00)	98 (81.87)	93 (74.66)	85 (67.21)	**94** (75.82)	100 (90.00)	99 (84.26)	96 (78.46)	92 (73.57)	**97** (80.03)
T_5	97 (80.03)	96 (78.46)	86 (68.03)	83 (65.65)	**91** (72.54)	97 (80.03)	97 (80.03)	90 (71.57)	86 (68.03)	**93** (74.66)
T_6	100 (90.00)	97 (80.03)	90 (71.57)	82 (64.90)	**92** (73.57)	100 (90.00)	98 (81.87)	94 (75.82)	90 (71.57)	**96** (78.46)
Mean	**98** (81.87)	**95** (77.08)	**86** (68.03)	**80** (63.43)		**98** (81.87)	**96** (78.46)	**90** (71.57)	**86** (68.03)	
TXP	**P_0**	**P_3**	**P_6**	**P_9**	**MEAN**					
T_0	97 (80.03)	93 (74.66)	81 (64.16)	77 (61.34)	**87 (68.87)**					
T_1	97 (80.03)	95 (77.08)	84 (66.42)	81 (64.16)	**89 (70.63)**					
T_2	97 (80.03)	95 (77.08)	85 (67.21)	82 (64.90)	**90 (71.57)**					
T_3	97 (80.03)	96 (78.46)	90 (71.57)	85 (67.21)	**92 (73.52)**					
T_4	100 (90.00)	99 (84.26)	95 (77.08)	89 (70.63)	**96 (78.46)**					
T_5	97 (80.03)	97 (80.03)	88 (69.73)	85 (67.21)	**92 (73.57)**					
T_6	100 (90.00)	98 (81.87)	92 (73.57)	86 (68.03)	**94 (75.82)**					
Mean	**98 (81.87)**	**96 (78.46)**	**88 (69.73)**	**83 (65.65)**						
	T	**P**	**C**	**TxP**	**PxC**	**TxC**	**TxPxC**			
SEd	0.446	0.337	0.238	0.893	0.477	0.631	1.263			
CD(P=0.05)	0.882	0.666	0.471	1.764	NS	1.247	2.495			

(Figures in parenthesis indicate arc sine values)

To-Control, T1-500 ^{n}T, T_2- 750 ^{n}T, T_3- 1500 ^{n}T. T_4- 500 ^{n}T + 750 ^{n}T, T_5-750 ^{n}T + 1500 ^{n}T, T_6- 500 ^{n}T +1500 ^{n}T.